Information Integration in a Decision Support System

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Electronic medical records pose a challenge because of the complex types of data which are included. Decision support systems must be able to deal effectively with these data types. In the expert system demonstrated here, a diversity of data types are included. These data are processed by three different methods. However, the different methods of processing are transparent to the user. An overall rule-based interface integrates the different methods into one comprehensive system.

INTRODUCTION

Medical decision support systems fall into several categories: knowledge-based systems in which information is represented as rules, frames, or some other symbolic structure [1], data-derived systems such as neural networks and pattern classification [2], and modeling approaches in which mathematical techniques are used to develop approximate models of biological systems [3]. In all these approaches, the wide variety of data types which are present in medical records must be handled. In our approach, these methods are combined into one decision support system [4]. The handling of different data types by different models is transparent to the user of the system.

SYSTEM STRUCTURE

Data Types

Data types include crisp data, fuzzy data, temporal data, and numerical representation of chaotic analysis. Some data items which appear to be crisp, for example, test results, are more accurately represented as fuzzy numbers which indicate the degree of precision of the test. Four types of temporal data are considered: change in value from previous value, change in value relative to a specified time interval, duration data, and sequence data. A measure developed by the authors which determines the degree of variability in time series data is also included.

Knowledge-Based System

The knowledge-based portion of the system utilizes approximate reasoning techniques which allows weighting of antecedents and partial presence of symptoms. The rule base is used as the interface which invokes the neural network model or time series analysis if certain rules are substantiated.

Neural Network Model

The neural network model is a three-level feed-forward model based on a non-statistical learning supervised learning algorithm developed by the authors [4]. Input data can be of any ordered form, including binary, categoric, integer, or continuous. The network can categorize data into two or more classes, and also produces a degree of membership for each class.

Time Series Analysis

Time series data, such as electrocardiograms, are important measurements for many diagnoses. An ECG may have an overall interpretation which can be used in the rule-based component, or categorized to be used in the neural network component. However, other analyses may also prove useful. In the application shown, a measure of variability for 24-hour Holter tapes is used.

Application

The combination of these techniques is illustration in a decision support system for the diagnosis and treatment of heart disease, including the use of a rule base, a supplementary neural network model of exercise testing data (ETT), and a time series analysis for Holter data.

CONCLUSION

The hybrid system described here has been shown to be a useful decision tool in cardiology. The general structure is readily adaptable to applications in other areas of medicine, and has already been used in prognosis of outcome in carcinoma of the lung and melanoma.

Reference

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